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MEASURING THE IMPACT OF GREEN BUILDING ATTRIBUTES ON PROPERTY VALUE AND IMPLEMENTATION COST: A TWO-WAY APPROACH

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Abstract

Green valuation is one type of valuation methods used to estimate the value of property by taking consideration the effect of the green features. Previous studies agreed that green features should be considered in valuation due to its features that have added value to the building. However, many researchers have shown notable obstacle in implementing green buildings which is the cost of implementation. Therefore, it is important to determine green features that has positive effect on property value and the implementation cost of green features. Henceforth, this study is conducted to compare between the effect of green attributes in increasing property values and implementation costs to be used as a guidance for green building industry. The objectives of this study are to identify green attributes on building by systematic analysis, to analyse the effect of green attributes on property value via questionnaire survey, frequency analysis followed by regression analysis. Lastly, to measure the implementation cost for green attributes that increased property value via interview with stakeholders. Based on the five hedonic model performed, it resulted that green roof, green wall, solar photovoltaics, double skin façade glazing, and green shade coverage are recommended to be implemented on buildings, as it increases property value. However, the lowest implementation cost is the green shade coverage implementation as it provides lowest cost compared to other green component at RM370/sqm with high property value increment at 39%. Therefore, it is suggested to implement green shade coverage on property to harvest both benefits. Overall, this study is significant for building industry decision making in green building development.

Keywords: High-rise Residential, Strata Residential, Green Features, Green Valuation

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INTRODUCTION

Green valuation known as the process of estimating the value of a green property in monetary by taking consideration of its green features where its focus on increasing the efficiency of the usage of energy, water and material resources and reducing impacts on human health and environment (GBI, 2013). Green building has an impact on the property value due to its green features such as energy efficiency, water efficiency, indoor environmental quality, sustainable, green materials, and construction, certification and government incentives and regulatory compliance (Cole, 2003). Thus, the property valuers will consider all green building attributes that are associated with sustainable improvement towards the building and the environment. Green building attributes such as green roof, green wall, solar photovoltaics, roof skylight, external window shading, and light shelves has been designed to maintain a safe and comfortable indoor environment (Shazmin et al., 2017; He et al., 2017; Alaidroos & Krarti, 2015). Green buildings also consist of green attributes such as location, accessibility, and neighbourhood (Porumb et al., 2020; Houghton & Castillo-Salgado, 2020).

According to Meins et al. (2010), green attributes are expected to contribute to property value. Based on past research, green attributes such as green roofs and green walls positively impact building value by 3% to 20% (Tomalty et al., 2010; Chen et al., 2014). A hedonic price regression has been done on stratified green residential buildings in Johor Bahru shows that green roofs and green walls provide value increments at 13% and 43%, respectively (Zulkifli et al., 2019). Besides, solar photovoltaics is also positively affecting property value, where it increases property value by 3% to 5% (Dastrup et al., 2012). Property valuation these days needs to be incorporated with the green features as well to promote and sustain the eleventh sustainable development goals.

From these studies, there is evidence regarding the positive impacts of these green attributes towards the property valuation, but none of these studies have integrated the feasibility and viability of these attributes in term of its implementations costs towards the property. To date, no research has comprehensively compared between green attributes that increase property value and the implementation cost. Henceforth, this research aims to compare green attributes that have effects in increasing property value and the implementation cost to serve as a guidance for the building industry in making decisions for green building development.

LITERATURE REVIEW

Green Attributes

Literature studies have identified that green building components such as green roof, turbine ventilator, solar water heating, solar photovoltaic, roof skylight, light pipe, green wall, light shelf, window external shading, and double skin façade glazing have various effects on property value.

A green roof effectively reduces the need for air conditioning in summertime, thus contributing to energy-saving in buildings (Rumana & Hamdan, 2009). Besides, turbine ventilator has been proven to control high energy consumption and improve the indoor environment (Wang et al., 2021; Qin & Pan, 2020). Solar water heating system is efficient in the deployment of renewable energies by using solar thermal energy to produce hot water, while improves the energy efficiency of buildings through its simple technology and a fast payback period (Taher et al., 2021; Vengadesan & Senthil, 2020).

According to Bhatia (2014), solar photovoltaics is a component that uses semiconductors that exhibit the photovoltaic effect to generate electricity by converting solar power to current electricity. The implementation of building-integrated photovoltaics effectively promotes low-energy buildings (Zhang et al., 2017). Meanwhile, roof skylight gives benefits in terms of an adequate level of daylighting and annual energy-saving (Chel, 2014). The light pipe is helpful as the daylighting device that can replace the artificial lighting requirement, which eventually reduces the CO₂ emissions in the environment and provides energy-saving (Sharma et al., 2018; Taengchum & Chirattananon, 2018; Roccia et al., 2012).

Green walls have been proven to promote energy savings, reduce sound transmission into buildings, contribute to greywater treatment and increase the envelope's longevity (Ascione et al., 2020; Besir & Cuce, 2018; Pradhan et al., 2019). The light shelf improved the daylighting distribution throughout the room, reduced daylight glare problem, and reduced lighting energy consumption (Lim & Heng, 2016; Lee et al., 2018). Window shading is a suitable approach to managing unnecessary heat access and reducing indoor environmental temperature (Dutta et al., 2017; Bessoudo et al., 2010). Natural ventilation through double-skin façades reveals favorable impacts in building energy-saving and delivers efficient cooling (Tao et al., 2021; Kyritsi & Michael, 2020). The findings by Qahtan (2019) suggested that the double-skin façade is efficient in regulating the heat gain event due to the change of temperature between outdoor and indoor and the variations in surface temperatures especially under the tropical climate like Malaysia.

Green Location

Green location attributes consist of attributes that are related to the location of the green residential and office buildings. The identified attributes are proximity to natural amenities, proximity to public transportation, and proximity to basic amenities. These factors are compared to the existing rating assessment tools developed by GBI, GreenRE, and Green Mark Scheme. The comparison between factors affecting residential and office value, and the existing assessment rating system can be seen in Table 1 below.

Green Neighbourhood

Green neighbourhood consist of attributes that are related to the site and neighbourhood of the property. The identified attributes are green space coverage, green shade coverage, and materials to prevent pollution. The difference in terms of the scales and policy is detailed in Table 1 below.

Effect of Green Attributes on Property Value

Numerous research has shown that green buildings have a higher property value than conventional building value based on Table 2 below which summarizes the literature review on the effects of green attributes on property value.

Table 2: Effects green features on property value

No.	Green attribute	Effect on value	Authors
1.	Green roof	Increase	Ibrahim et al. (2014), Ichihara & Cohen (2011), Tomalty et al. (2010)
		Decrease	Chen et al. (2014)
2.	Turbine ventilator	Increase	Ibrahim et al. (2014)
		No effect	Shazmin et al. (2017)
3.	Solar water heating	Increase	Ibrahim et al. (2014)
		No effect	Shazmin et al. (2017)
4.	Solar Photovoltaic	Increase	Hoen et al. (2011), Dastrup et al. (2012)
5.	Roof skylight	Increase	Sipan et al. (2014)
		No effect	Shazmin et al. (2017)
6.	Light pipe	Increase	Ibrahim et al. (2014)
		No effect	Shazmin et al. (2017)
7	Green wall	Increase	Manso et al. (2020), Perini & Rosasco (2013), Gao & Asami (2007)
8.	Double skin façade glazing	No effect	Shazmin et al. (2017)
9.	Window external shading	No effect	Shazmin et al. (2017)
10.	Light Shelf	Increase	Ibrahim et al. (2014)
		No effect	Shazmin et al. (2017)
11.	Green space coverage	Increase	Holt and Borsuk (2020)
12.	Green shade coverage	Increase	Nepal et al. (2017)
13.	Material to prevent pollution	Increase	Amaral et al. (2020)

Table 1: Green attributes for location and neighbourhood based on green rating tools.

Attribute	Green rating tools		Green Attribute
	Green Building Index (GBI)	Green Real Estate Green Mark Scheme (GreenRE)	
Location	Proximity to natural amenities	SM1 – SITE SELECTION AND PLANNING	Not stated.
	Proximity to public transportation	SM8 – PUBLIC TRANSPORTATION ACCESS	RES 3-5 GREEN TRANSPORT
	Proximity to basic amenities	SM3 – COMMUNITY CONNECTIVITY	RES 3-8 COMMUNITY CONNECTIVITY
Office building			
Location	Proximity to public transportation	Not stated.	ENRB 3-7 GREEN TRANSPORT
			SM1-10 GREEN TRANSPORT
			Walking distance to public transport <500m.
Neighbourhood	Green space coverage	SM11 – HEAT ISLAND EFFECT	RES3-3 GREENERY PROVISION
			Residential building
			PART 1-2 URBAN HEAT ISLAND
			Green space with native & adaptive plants and/or water body to 15% to 80% of land area.

Green shade coverage	SM8 – PUBLIC TRANSPORTATION ACCESS	Not stated.	Not stated.	Covered walkway at least 70% of the pedestrian access.
Quality of neighborhood and pollutions (Materials to prevent pollution)	EQ6 – SOUND INSULATION EQ2 – VOLATILE ORGANIC COMPOUNDS MINIMISATION SM6 – WORKERS' SITE AMENITIES	RES3-4 ENV MGMT PRACTICE RES4-1 NOISE LEVEL RES4-2 INDOOR AIR POLLUTANTS	PART 3-3 WASTE PART 4-2 ACOUSTICS PART 4-1 CONTAMINANTS PART 1-2 SUSTAINABLE STORM WATER MANAGEMENT	Reduce the detrimental impact on occupants' health from finishes that emit air pollutants. 90% of no paint and coating used. Provide septic tank. Recycling bins at each block Noise level 70 metres away from building boundary. Use of low VOC emitting interior finishes Treatment of at least 10% storm water run-off from total site area
Office building				
Neighbourhood Green space coverage	SM6 – GREENERY & ROOF	ENRB 3-5 GREENERY PROVISION	SM 1-8 GREENERY	Vegetated roof and façade at least 20%-50% of the area.
Green shade coverage	SM6 – GREENERY & ROOF	ENRB 3-7 GREEN TRANSPORT	SM 1-10 GREEN TRANSPORT	50% of covered walkways to nearest public transport networks
Quality of neighborhood and pollutions (Materials to prevent pollution)	EQ4 – INDOOR AIR POLLUTANTS EQ13 – INTERNAL NOISE LEVELS	ENRB 3-3 WASTE MANAGEMENT ENRB 4-2 INDOOR AIR POLLUTANTS ENRB 4-5 INTERNAL NOISE LEVEL	RS 3-8 RECYCLING FACILITIES SHB 4-4 INDOOR CONTAMINANTS SHB 4-6 ACOUSTICS	No paint, coating, and adhesive. Ultraviolet Germicidal Irradiation (UVGI) system Maintain internal noise level at 90% of the NLA. Noise level Recycling bins provision.

METHODOLOGY

Objective 1: To identify green attributes on building

The identification of green attributes for property is conducted through rigorous literature reviews. The literature review is conducted to determine green attributes that appropriate for green buildings in Malaysia. The green benefits of each green attribute are gathered from the literature to be matched with green criteria listed under the green building assessment tool. The results of data collection from literature review derived by using systematic analysis.

Objective 2: To analyse the effect of green attributes on property value

There are three stages involved to achieve objective 2, which are the distribution of the questionnaire, site inspection, and market transaction data collection. The first stage of the objective is the questionnaire survey. The questionnaires are constructed based on the findings of objective 1 and distributed among property valuers in Malaysia. This study has adopted probability sampling, which is simple random sampling. There is a total of 1684 property valuation practitioners in Malaysia and with a sampling error of $\pm 10\%$, the number of minimum samplings required for this study is 94. The 5-point Likert scale is used in the questionnaire survey which ranges from increase value to decrease value. The second stage of objective 2 involves selected case studies of stratified green residential and special purpose green office buildings in Kuala Lumpur as it is the state with highest number of green building implementations. In terms of questionnaire survey, data reliability is assessed through Cronbach's alpha coefficient and data is analysed using frequency and descriptive analysis. Then, a total of 1165 data set of residential building that has been collected from NAPIC, JPPH KL and are used in the hedonic regression model. Data cleansing is conducted to identify and fix incomplete and incorrect data. The selected variables consist of basic factors, facilities factors, and green components. The Statistical Package for the Social Sciences (SPSS) tool is used to analyse the collected data.

Objective 3: To measure the implementation cost for green attributes that increased property value

Information regarding the cost of implementing green attributes on property that has positive effect is conducted by interviewing landscape contractors, building contractors, material suppliers, service providers, and other relevant stakeholder who have experience in cost of implementing green attributes. Thus, the guidance and advice from the professionals relating to the green attributes could enlighten the quotation for the implementation cost of green attributes. Costing analysis which comprises of direct costing where it is used to estimate the total cost of property increment for implementing green attributes. Cost is obtained based on the interview session conducted with relevant stakeholders.

RESULTS AND DISCUSSION

Effects of Green Attributes on Property Value Based on Valuer Perceptions

In this study, the reliability of the Cronbach's alpha coefficient is 0.862. It shows that the Cronbach's alpha coefficient score is more than 0.8 where it indicates that the data gathered are good and reliable. This study proves that solar photovoltaics, solar water heating, roof skylight, double skin façade glazing, window external shading, green roof, and green wall increase property value. This finding is aligned with past research (Hoen et al., 2011; Dastrup et al., 2012; Ibrahim et al., 2014; Manso et al., 2020; Perini and Rosasco, 2013). Besides, proximity to public transportation, proximity to basic amenities, green space coverage, and green shade coverage for office resulted to increase property value. This study also supports past research on turbine ventilators, light pipes, and light shelves as green attributes that have no effect on property value (Azis et al., 2017; Chen et al., 2014). The provision of green space coverage, green shade coverage for residential, and material to prevent pollution also does not have any effect on property value. Furthermore, property value is expected to decrease if situated near natural amenities based on the valuer perspective. From this, Table 3 below presents the overall summary on effect of green attributes property value from valuer perspective.

Hedonic Price Regression Model on Effect of Green Attributes on Property Value

Table 4 below presents the comparison between the effect of green attributes on residential market value from valuer perspective and hedonic model percentages. Referring to the valuer perspective, there are ten green attributes that provide positive effect on residential market value which consists of five green component attributes, and five green location attributes. However, green neighbourhood attributes resulted in no effect on residential market value. Contrasting from the valuer perspective, hedonic model resulted that there are eight green attributes consist of four green component attributes, three green location attributes and one green neighbourhood attributes that provide positive effect on residential market value from 0.40% to 38.70%. Meanwhile, there are nine green attributes that provide negative effect on residential market value from 1.30% to 40.90%.

Table 3: Summary on effect of green attributes property value from valuer perspective

No.	Attribute	Effect on value					
		Residential			Office		
		Increase	No effect	Decrease	Increase	No effect	Decrease
Green component:							
1.	Green roof	/			/		
2.	Solar water heating	/			/		
3.	Solar photovoltaics	/			/		
4.	Roof skylight	/			/		
5.	Green wall	/			/		
6.	Double skin façade glazing	/			/		
7.	Window external shading	/			/		
8.	Turbine ventilator		/			/	
9.	Light pipe		/			/	
10.	Light shelf		/			/	
Green location:							
11.	Proximity to natural amenities:		More than 31m	Within 30m		-	-
12.	Proximity to basic amenities	Within 1000m	More than 1000m				
13.	Proximity to public transportation:						
1)	Public transport stops	Within 1000m	More than 1000m		Within 30m	More than 751m	Between 31m - 750m
2)	Public transport interchange	Within 1000m	More than 1000m		Within 30m	More than 751m	Between 31m - 750m

No.	Attribute	Effect on value					
		Residential		Office			
		Increase	No effect	Increase	No effect	Increase	Decrease
Green neighbourhood:							
14.	Green space coverage:	21% - 80%		0% - 20%	61% - 80%	0% - 60%	
1)	Green space						
15.	Green shade coverage:		0% - 80%	21% - 80%	0% - 20%		
1)	Green shade						
16.	Materials to prevent pollution:						
1)	Low VOC paint	/	/	/	/	/	/
2)	Sound transmission wall	/	/	/	/	/	/
3)	Proper septic tank	/	/	/	/	/	/
4)	Reduce finishes that emit air pollutants	/	/	/	/	/	/
5)	Stormwater treatment	/	/	/	/	/	/
6)	Recycle bin provision	/	/	/	/	/	/
7)	UVGI air quality system	-	-	-	-	-	-

Table 4: Effect of green attributes on residential market value

Variables	Valuer perspective	Hedonic model (%)	
		Positive	Negative
Green Components:			
1) Green roof	Increase value	0.40	
2) Solar photovoltaics	Increase value	33.30	
3) Green wall	Increase value	3.40	
4) Double skin façade glazing	Increase value	18.20	
5) Window external shading	Increase value		1.30
Green Location Attributes:			
Proximity to public transportation:			
1) Public transport stops – within 500m	Increase value	12.20	
2) Public transport interchange – within 1000m	Increase value	13.40	
Proximity to basic amenities:			
3) School – within 1000m	Increase value	9.80	
4) Supermarket – within 1000m	Increase value		22.50
5) Police and fire station – within 1000m	Increase value		40.90
Green Neighbourhood Attributes:			
Green shade coverage:			
1) Covered walkways – at least 70%	No effect on value	38.70	
Materials to prevent pollution:			
2) Low VOC paint	No effect on value		6.50
3) Sound transmission wall	No effect on value		9.90
4) Septic tank	No effect on value		40.60
5) Reduce finishes that emit air pollutants	No effect on value		5.90
6) Stormwater treatment	No effect on value		25.30
7) Recycle bin provision	No effect on value		26.50

Implementation Cost for Green Attributes

To derive the implementation cost, data is collected through interview among landscape contractors, building contractors, material suppliers, service providers, and other relevant and experience stakeholder. A total of nine service provider was interviewed at different dates to calculate the costings and the quotations is used as the costing data. The costing analysis only highlights the findings for implementation cost for green component attributes and green neighbourhood attributes that have positive effect on both residential market value and office rental value as these are the attributes that should be focused in the property valuation industry specifically by the valuers and the property owners. Hedonic model reveals several green attributes that have positive effect on residential market value and office rental value. There is only one green neighbourhood

attributes to derive its implementation cost that has positive effect on residential and office building value which is green shade coverage. Table 5 presents the summary of green components implementation cost for residential and office building.

Table 5: Costing for green components attributes

Green components	Total cost (RM/sqm)	
	Min.	Max.
<i>Green component attributes</i>		
Green roof	3,770	5,060
Green wall	5,170	7,100
Solar photovoltaics	1,500	1,800
Double skin façade glazing	1,586	
<i>Green neighbourhood attributes</i>		
Green shade coverage	370	

Results found that green roof, green wall, solar photovoltaics, double skin façade glazing, and green shade coverage are recommended to be implemented on buildings, as it increases property value. However, the lowest implementation cost is the green shade coverage implementation. It provides the lowest cost compared to other green component at RM370/sqm with high property value increment at 39%.

CONCLUSION

In conclusions, this research has discovered that green roof, green wall, solar photovoltaics, double skin façade glazing and green shade coverage can increase property value via its existence on the valued properties. The developed models and the study results could be a guidance to the valuers, developers, and policymakers on promoting the implementation of green attributes on buildings. Apart from that, several limitations exist in this study such as the geographical focus of this study is only in Kuala Lumpur, small sample size and the costing were obtained only the for the attributes that have positive impacts. Future studies can explore the green attributes on buildings all over Malaysia together with considering larger sample size and deriving the costings for all the identified green attributes. Overall, this paper provides insights on the feasibility of green attributes implementation on buildings which provides benefits in terms of property value improvement and concurrently increasing sustainability.

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